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IMPROVED NOISE MANAGEMENT SYSTEM FOR REDUCING AIRBORNE AND STRUCTURE BORNE NOISE OF A VEHICLE EXHAUST SYSTEM

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FIELD OF INVENTION

The present invention relates generally to active noise cancellation systems for vehicles, and more particularly to the arrangements for coupling a noise cancellation system to an exhaust component of a vehicle.

BACKGROUND

Active noise cancellation systems typically operate by creating a noise cancellation signal which is equal-in sound pressure and opposite in phase with a primary noise signal. When combined, the two signals would ideally cancel one another out thus reducing the total airborne noise produced by a machine or by a vehicle.

Such systems may be employed to reduce noise produced by an engine exhaust in a motor vehicle. However, the actual implementation of coupling the acoustic output of an exhaust system and a noise cancellation signal may be problematic depending on the design constraints of the vehicle. For example, one known system employs a cylindrical prism routing a noise cancellation signal through an open end of a first cylinder, and exhaust gasses through a second cylinder perpendicularly connected to the a side wall of the first cylinder. The silenced exhaust gasses exit from the opposite end of the first cylinder. Such an arrangement requires joining the intersection of two cylinders and has proven difficult to execute reliably. Furthermore, the routing of the exhaust gasses impinges the gasses against the inside of the cylindrical prism creating turbulence within the cylindrical prism. This turbulence causes vibration of components and results in an undesirable secondary structure borne noise issue.

SUMMARY OF INVENTION

Accordingly, one aspect of the present invention is to provide a noise management device which is desirable for use in a system having a noise cancellation signal and an exhaust stream arriving perpendicular to each other.

Another aspect of the present invention is to provide a noise cancellation enclosure which reduces or eliminates turbulence within the enclosure.

Yet another aspect of the present invention is to provide a noise cancellation system suitable for use in a vehicle having a side-exiting exhaust.

In accordance with these aspects, a noise management arrangement is provided. In an active noise cancellation system having exhaust noise and anti-noise initiating at sources positioned perpendicular to each other, the noise management arrangement has a noise cancellation enclosure containing a noise cancellation space. The space is in communication with a noise cancellation port and has an exit port coaxial with the noise cancellation port. An opening receives the exhaust noise from an exterior of the enclosure and communicates the exhaust noise into the space and directs the noise towards the exit port, thereby minimizing the exhaust noise that impinges upon the enclosure.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood however that the detailed description and specific examples, while indicating preferred embodiments of the invention, are intended for purposes of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 illustrates a plan view of an embodiment of a noise management device.

Figure 2 illustrates a side view of an embodiment of a noise management device.

Figure 3 illustrates a perspective view of a noise cancellation enclosure.

DETAILED DESCRIPTION

The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention, its application or uses.

Figure 1 illustrates a plan view of an embodiment of a noise management arrangement 1 having a noise cancellation enclosure 10 for combining the acoustic output of a vehicle exhaust component 40 with the acoustic output of an active muffler speaker enclosure 50. The enclosure 10 may be formed from metal, such as aluminum. The noise cancellation enclosure 10 has an arcuate wall 16. The arcuate wall 16 is substantially planar in the view axis and preferably has a curvature of radius R about point 26 as shown in Figure 1. An outer shell portion 18 is integrally formed with the arcuate wall 16, and includes opposing side wall portions 22 and 20, to define a noise cancellation space 12. An exit port 24 is formed in the enclosure 10 to provide an outlet for exhaust gasses.

A pipe 42 is positioned within an opening 28 formed in arcuate wall 16. The pipe 42 provides a path for noisy exhaust gasses to enter the enclosure 10. The pipe 42 has an inner spout portion 14 for directing the exhaust gasses toward the exit port 24. A noise cancellation port 58 is positioned within a second opening 30 which is also formed in the arcuate wall 16. The second opening 30 is preferably coaxial with exit port 24. In this manner, the present invention can reduce and/or minimize any undesirable resonance of

enclosure 10 by generally aligning the second opening 30 and exit port 24 relative to the exhaust gas flow.

A microphone 44 is positioned near the exit port 24. The microphone detects noise emitting from the exit port and converts the noise to an electrical signal. The electrical signal is connected to a control unit 46. The control unit 46 has an electrical output connected to a speaker (not shown) located within speaker enclosure 50.

The enclosure 10 may be combined with a hanger assembly to facilitate mounting the noise management arrangement 1 to a vehicle (not shown). An exemplary hanger assembly is shown having first and second clamping prongs 36, 38 positioned on the enclosure 10. The clamping prongs 36, 38 are also secured to an isolator 34, preferably made of rubber. The isolator is clamped in an isolator mount 32 with an integral bracket 60, which may be positioned on the underside of the vehicle.

An exhaust clamp 54 is provided for attaching the exhaust component 40 to the pipe 42. An enclosure clamp 52 is also provided for attaching a speaker enclosure 50 to noise cancellation port 58.

Figure 2 illustrates an end view of noise management arrangement 1 as seen looking into exit port 24. The inner spout portion 14 is visible through the exit port 24. The inner space 12 is also visible within enclosure 10. The exhaust acoustic output is combined with the noise cancellation acoustic output in inner space 12. This view also illustrates the manner in which flow from the pipe 42 and flow from the noise cancellation port 58 are directed toward the exit port 24 of the noise cancellation enclosure 10. In this embodiment, the assembly of the exhaust component 40, active muffler 20, speaker enclosure 50, and noise cancellation enclosure 10 components are

oriented to release exhaust from the side of the vehicle. A screen 56 may be provided for preventing debris from entering the noise cancellation port 58.

Turning to Figure 3, an elevated view of the noise cancellation enclosure 10 is shown. Openings 28 and 30 are formed in an arcuate wall 16. Curved side wall 20 extends perpendicularly from an end of arcuate wall 16 and terminates to form a portion of exit spout 24. Side wall 22 extends perpendicularly from the opposite end of arcuate wall 16 and terminates to form another portion of exit spout 24. A first cover portion 48 has a perimeter positioned along the side wall 22, arcuate wall 16, and the curved wall 20. A segment of the first cover portion's perimeter also forms a further portion of exit spout 24. A second cover portion 18 is in spaced relation to the first cover portion 48 and similarly has a perimeter positioned along the side wall 22, the arcuate wall 16, and the curved wall 20. The segment of the second cover portion's perimeter forms the remainder of exit spout 24. The arcuate wall 16, side wall 22, curved wall 16, first cover portion 48, and second cover portion 18 in spaced relation to the first cover portion, define a noise cancellation space 12.

For the noise cancellation enclosure 10 to provide a desirable environment for mixing sounds from the noise cancellation port 58 and the exhaust component 40, an attempt should be made to satisfy certain dimensional relationships. Firstly, the cross sectional area of the exit port 24 should be at least 10% greater than the sum of the cross sections of the opening 28 for pipe 42 and the opening 30 for the noise cancellation port 58. Secondly, the spatial volume of the noise cancellation space (V_{12}) less the spatial volume of the inner spout portion (V_{14}) should be greater than or equal to twice the

spatial volume of the noise cancellation port (V_{58}). Stated mathematically, $V_{12} \cdot V_{14} \geq 2V_{58}$.

The operational aspects of the noise management device will now be described. The sound of the exhaust gasses exiting from the exhaust component 40 has certain undesirable noise components. These noise components have a frequency and amplitude as is known in the art. The exhaust gasses are routed into the noise cancellation enclosure 10 via pipe 42. The inner spout portion 14 prevents the exhaust gasses from impinging upon the side wall 22, thereby causing an undesirable resonance which may be conducted to the vehicle via the hanger assembly. A microphone 44 placed in the proximity of exit spout 24 senses the noise and converts it to an electrical waveform, which is conducted to the control unit 46. The noise cancellation device detects the undesirable frequency and amplitude of the noise and in response thereto creates anti-noise having an equal amplitude and frequency with an opposite phase. The noise cancellation device then sends the anti-noise waveform to a speaker located within speaker enclosure 50. The anti-noise waves generated by the speaker are conducted through the noise cancellation port 58 and into the noise cancellation space 12. Once the anti-noise sound waves reach the noise cancellation space 12 they destructively interfere with the noise, thereby reducing its amplitude.